7. A Contribution to the Anatomy of the Three-toed Sloth (*Bradypus tridactylus*).

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(Plates I.–IV. & Text-figures 10–15.)

The observations recorded here were made on the body of a female *Bradypus tridactylus* which died a few hours after admission to the Society's Gardens. It was deposited, so I was unable to make a complete dissection, and my investigations were, in consequence, limited to the mouth, tongue, and organs of the thorax and abdomen. Some of the conditions observed have not been recorded before, and others differ from those which have already been described. The organs were compared with those of *B. gularis* or *cucullíger*, which are preserved in the Museum of the Royal College of Surgeons.

The Mouth.

The Vestibule.

The form and communications of the vestibule depend on the shape of the maxillæ and the size and distribution of the teeth. When the skull is examined it is seen that the premaxillæ are edentulous, so there is a gap in front between the first pair of teeth in the upper jaw (Plate I. C), and there is a similar gap in the lower jaw. Consequently, when the lips are everted, one can see the tip of the tongue. In *Cholœpus*, on the other hand, the prominent rostrum, or beak, of the lower jaw diminishes the gap in the centre.

The mucous membrane does not form a vestibular pocket in front, as in most mammals, for it passes direct from the margins of the jaws to the free edge of the lips. Consequently, the vestibule in front has no wider area than the orifice of the lips (Plate I. A).

The first pair of upper teeth are small, and the second pair are large and project laterally (Plate I. C). Between the mid-line in front and the second pair of teeth the upper jaw expands, but it narrows behind them, and, as the cheeks are not closely applied to the sides of the jaw, the vestibule is patulous and increases in width from before backwards (Plate I. B, *v*). In the case of the lower jaw, however, the cheeks are closely apposed against the gum and the vestibule is reduced to a mere slit.

Posteriorly the communications between the vestibule and mouth-cavity behind the last pairs of teeth in both jaws are exceedingly small.

In *Cholœpus* the vestibule and mouth-cavity communicate through the gaps between the first and second pairs of teeth in both jaws (Plate I. D).

The Hard Palate (Plate I. B).

The hard palate is 2·7 cm. long, ·8 cm. wide between the first pair of teeth, 1 cm. wide between the second pair of teeth, and ·7 cm. wide between the last pair, so it first expands and then contracts. It is encircled just internal to the teeth by a series of *palatal tubercles* which, however, have no counterparts on the dorsum of the tongue. On each half of the palate there are seven of these—one opposite each tooth, one anterior to the first tooth, and one at the side of the mid-line: the first and second are borne by the premaxillæ. The tubercles increase in size from before backwards, and the fifth pair is the largest.

The palate has the same chocolate *colour* as the labial margins. Running along the mid-line is a white streak which sends out branches to end on the mesial sides of the tubercles. In the posterior part this streak overlies the crest shown in Plate I. C.

When the mucosa is removed from the subjacent bone, it is seen that the palatal tubercles do not cover bony eminences, and the bone differs greatly from that of *Cholœpus* (Plate I. D).

In *B. tridactylus* there is a strong median crest on the posterior half, and there is a gutter on each side of that ridge. Anteriorly each gutter is converted into a tunnel by a fenestrated bridge of bone; the tunnel on the right side reopens on to the free surface, but the left one does not. Both gutters, however, communicate posteriorly with the nasal fossæ.

In the mid-line in front there is a groove which widens from behind forwards, but, as the premaxillæ were lost in the preparation of the skull, I am unable to give a complete description of it.

The bone is much perforated by small foramina. Some of these open into the afore-mentioned tunnels and the others into the nasal cavity.

No sutures are present outlining the various elements comprising the bony palate as in *Cholœpus*.

The bony palate of *Cholœpus* differs in many ways from that of *Bradypus*. It is much larger and its constituent bones are clearly outlined by sutures. There is no gutter nor ridge on the posterior part, but many foramina of different sizes are present. Of these, there is a large pair on the palate bones lying posterior to the fifth pair of teeth, and a large pair on the maxillæ in front. The former, probably, correspond to the gutters of *Bradypus*.

The Soft Palate.

The soft palate, which measures 1·2 cm. from before backwards, is pink in colour. It is attached to the posterior extremity of the hard palate in front, and to the prominent pterygoid plates laterally. No hamular pterygoid processes are palpable through it, but the convex free borders of the plates can easily be felt. Its posterior edge is concave backwards, and its oral surface

bears a small tubercle in the mid-line at a distance of 1 mm. from the free edge (Plate I. B). There is, however, no uvula, as was pointed out by Rapp (10).

The Teeth.

The teeth have been fully described in their structural and developmental aspects by Rapp (10), Semon (11), and others, and I have nothing to add to their accounts.

The Tongue (text-fig. 10).

Rapp (10) has given some scanty details of the tongue, so a detailed description is required.

My fresh specimen has the following *measurements*:—Length from the apex to the epiglottis, 3·85 cm.; length of the oral part, 2·89 cm.; length of the pharyngeal part, ·96 cm.; greatest width (*i. e.* between the lingual attachments of the anterior faucial pillars), 1·7 cm.; width of the apex, ·7 cm.; thickness in the vallate papillary region, 1·25 cm.; thickness at a point 1·4 cm. posterior to the apex, 1·1 cm.; thickness of the apex, ·4 cm.

The tongue is, therefore, short, narrow, and thick. Its width first decreases rapidly, but later maintains a constant dimension to the apex. The thickness remains almost uniform, on the other hand, in the posterior two-thirds and then rapidly decreases towards the apex.

The *apex* has a fine mesial notch, and is covered with small conical and large flat fungiform papillæ. There is a faint *mesial sulcus* which, however, is irregular, and the lens shows how it is replaced in parts by fungiform papillæ; the latter are, however, invisible to the naked eye. The *lateral borders* are massive, and have a single row of large fungiform papillæ; they also possess vertical rows of conical papillæ with backwardly-directed points. No *lateral organs* are present, as shown by Gmelin (13).

The two *circumvallate papillæ* lie side by side, and both are circular and polished. When the tongue is fresh their free surfaces are flush with the surface of the tongue. When, however, it is placed in preserving fluid the papillæ are retracted within their fossæ, thus demonstrating an action similar to what occurs in Monotremes and some Marsupials. The vallums are prominent, granular, and surrounded by conical papillæ. Mayer (14) saw three papillæ.

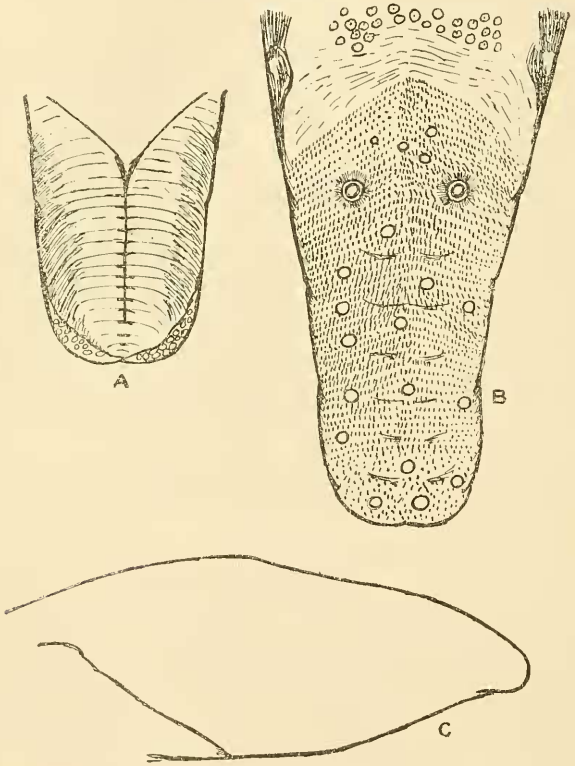
The *fungiform papillæ* are large, flat, and not numerous. They have the usual arrangement in clusters and rows of varying degrees of obliquity which characterises the Mammalian tongue. They extend from the apex back beyond the vallate papillæ, but they stop short of the zone of lymphoid tissue on the base. They form a single row on the lateral borders of the tongue, but the papillæ of the row are discrete.

The *conical papillæ* are all filiform and possess one or more points; those in the mid-line have their points directed backwards, but those at the sides look backwards and inwards. They

increase in size from before backwards and from without inwards, and they are discrete, so there is no overlapping. They extend beyond the vallate papillæ, and there is a sharp line of demarcation between them and the lymphoid tissue at the base.

On the base of the tongue there are many *lymphoid nodules*, some of which have central apertures, and there is a line, convex backwards, separating the papillary and lymphoid areas.

Text-figure 10.



The tongue. A: inferior surface. B: dorsum. C: lateral view.

No *lytta* is present as Rapp showed (**10**).

The *inferior surface* has a narrow papillary border. There is a fine mesial notch, but no mesial ridge, sulcus, nor frenum. The surface is marked by fine horizontal ridges, but there are no plicæ fimbriatæ. The papillary border forms thick masses at either side of the apex.

The tongue, according to Rapp, is mechanical rather than gustatory in function.

The Stomach.

The external appearances have been described by Cuvier (3), Meckel (7), Carus (2), Otto, Boulart, and Pilliet (9), and the internal appearances of the stomach of *B. cuculliger* have been described by Rapp (10) and Klinckowström (6). Many details can be added, however, to their accounts. Moreover, the internal appearances and the relative positions of the various compartments are different in *B. tridactylus* and *B. cuculliger* or *gularis*.

The *stomach bed* in my specimen is unusual, for the position of the pancreas is peculiar; that organ is contained within the duodenal loop and none of it lies dorsal to the stomach. Again, the stomach bed does not contain the spleen, for the latter, in Sloths, lies on the right side of the pylorus. The kidneys lie far back in the abdomen, and the suprarenal capsules are separated from them, but lie in the normal position. Consequently, the adrenal bodies are dorsal relations of the stomach, but the kidneys are posterior. In my specimen the stomach has the following relations:—

Anterior—liver and diaphragm.
Posterior—intestines and kidneys.
Ventral—ventral abdominal wall.
Dorsal—vertebral column, main blood-vessels, suprarenal capsules, root of the mesentery.
To the left—abdominal parietes.
To the right—spleen, pancreas, duodenum.

These peculiar arrangements make the disposition of the peritoneum, which is described below, noteworthy.

In my specimen the gravid uterus touched the greater curvature.

Divisions of the Stomach.—I agree with Klinckowström's division of the stomach into three groups of compartments:—

1. The Paunch, or Fundus Stomach, with its cæcal appendage (Plate II. A, C and B, I.I.I.).
2. The Cardiac Stomach with three divisions (Plate II. A, D and II. B, *d. c. d*, 2).
3. The Pyloric Region composed of two parts—glandular and muscular (Plate II. B 3).

In *B. tridactylus* the main divisions, and most of the subdivisions, can be distinguished on the surface. The paunch is marked off from the cardiac stomach by a notch on the left part of the greater curvature (Plate II. A, A) and a faint ridge running from the notch to the base of the cæcal appendage. This ridge marks the anterior limit of a number of fissures running forward from the greater curvature, but these are not so deep as in *B. cuculliger*. The cardiac stomach is easily marked out from the pylorus; it is capacious and has thin walls, but the pylorus is a thick, muscular, U-shaped tube.

The relative positions of these divisions are different in *B. tridactylus* and *B. cuculliger*. The reader is referred to the works of Rapp (**10**), Klinckowström (**6**), and Oppel for descriptions of the latter. Klinckowström's paper is the best, for it is profusely illustrated. Moreover, there is an excellent specimen of the stomach of *B. gularis* in the Museum of the Royal College of Surgeons. Klinckowström described the histology.

When the stomach of *B. tridactylus* is examined from the ventral aspect (Plate II. A), one sees the paunch (Plate II. A, C) posterior and to the left; the cardiac stomach (Plate II. A, D) anterior and to the right; and the ventral part of the pylorus (Plate II. A, H) lying most to the right. The entire pylorus is not visible on the ventral surface as in *B. cuculliger*. When the stomach is viewed from the right, one sees the U-shaped pylorus consisting of dorsal and ventral limbs, and a posteriorly-placed bend (text-fig. 14 A, *py*). The dorsal limb emerges from the cardiac stomach, and the ventral limb communicates with the duodenum. In *B. cuculliger* the limbs are anterior and posterior with the bend to the left. When the stomach is viewed from the dorsal aspect, one sees the paunch posterior, the cardiac stomach anterior, and the dorsal limb of the pylorus to the right. The U-shaped pylorus is seen in Plate II. B 3.

The simple, conical, cæcal appendage of *B. tridactylus* is longer and more slender than in *B. cuculliger*. Its position may vary, but in my specimen it first passed from the posterior and right part of the paunch to the right. It was then recurved on itself, and its apex rested on the cardiac stomach. It is also more slender than in *Cholœpus*.

No author has described the peritoneal sheet connecting the cæcal appendage to the paunch (Plate II. A, B). This is triangular, and fills up the space between them. Its apex lies along the anterior border of the appendage, and there is a sharp free border looking forwards and to the right. The right gastric vessels run between its layers as they separate to surround the appendage (Plate II. A, J).

The right gastric artery reaches the ventral surface of the stomach to the right of the œsophagus and passes posteriorly and to the right. It ends about the middle of the cæcal appendage. It is accompanied by the right gastric vein, and all the gastric lymphatic glands lie alongside it.

Rapp (**10**) and Klinckowström (**6**) have described the internal structure of the stomach of *B. cuculliger*, and that of *B. tridactylus* agrees with it in most points. Their accounts, however, can be amplified in several ways. Speaking generally, the cardiac stomach has a mechanical function, the paunch and appendage are secretory, and the pylorus has both properties.

The division between the paunch and cardiac stomach is marked by a strong, thick ridge (Plate II. B, *a*) and a second ridge into which the point of the pin is inserted, corresponding to the white line seen externally on the ventral surface. It marks

the transition between the rugose smooth mucosa of the paunch and the hard mucosa of the cardiac stomach.

The *three divisions of the cardiac stomach* are separated by partitions, and the septum between the two ventral compartments runs for some distance along the inner surface of the paunch (Plate II. B, *pin*). Microscopic sections of this septum (Plate IV. B) show the transition between the stratified epithelium of the cardiac stomach and the glandular lining of the paunch. The septum between the dorsal and left ventral compartments (Plate II. B, *c*) is small and strong. The former septum is absent in *Choloepus*. The epithelial transition is similar to the junction of the œsophagus and a simple stomach.

The *inner surface of the paunch* is beset with rugæ whose characters differ on the two sides of the septum running back from the cardiac stomach. On the left side they run in all directions and are mostly small; on the right side they are mostly large, and pockets are enclosed between them and the gastric wall. One very large septum bisects the cæcal appendage; in Plate II. B one of the halves is laid open, and a glass rod passes down through the other one. Between the rugæ, which are soft and flabby, the mucosa has innumerable small glandular pits.

On the right side there are several small, firm ridges passing to the large ridge between the paunch and cardiac stomach, but they are absent on the left side, for the soft mucosa extends right forward to that ridge (Plate II. B, *a*); and these small ridges are seen above *d* in Plate II. B.

The *interior of the cæcal appendix* has been incompletely described by Rapp (**10**) and Klinckowström (**6**), and no illustrations are provided by them. Its inner structure is shown in Plate II. B, and a cross section is diagrammatically represented in text-fig. 12, B. It is ridged by many longitudinal folds, but these are reduced to six in number in the terminal third. The upper two-thirds of the cavity is bisected by a large septum, and small partitions attached to it enclose two pockets on either side. These all open towards the paunch, and the arrows in text-fig. 12 B pass through the two passages on either side of the main septum.

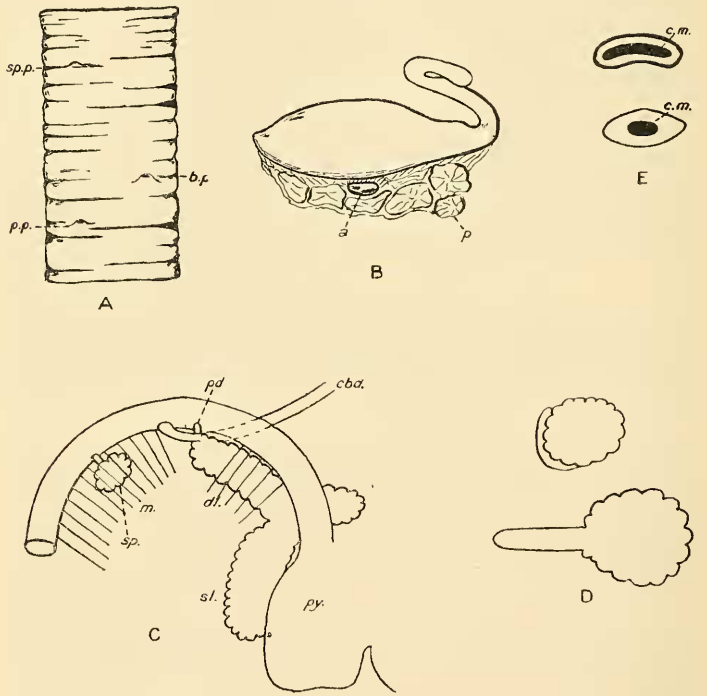
A prominent muscular ridge (Plate II. B, *b*) runs from the greater curvature into the left ventral compartment of the cardiac stomach, and ends on the septum between the latter and the dorsal compartment. A second ridge runs from the septum between the two ventral compartments to meet the former ridge, and between them is the opening between the dorsal and left ventral compartments of the cardiac stomach.

The œsophagus is continued right into the pylorus by a groove running through the left ventral and dorsal compartments of the stomach. It is shown in Plate III. A, *a*, and its characters are the same as those already described by Rapp and Klinckowström.

The *pyloric region*, which is **U**-shaped, has dorsal glandular

and ventral muscular divisions. Its histological characters have been thoroughly described (**6**), and I have nothing to add to that account. Running along the floor is a ridged groove continuous with the groove from the paunch into the cardiac stomach, and Rapp (**10**) thinks it has a ruminating function. The communication between pylorus and duodenum is guarded by a strong valve (Plate III. C, *a*), but Rapp states that there is no pyloric sphincter.

Text-figure 11.



A: Interior of the duodenum. *b.p.*, bile papilla; *p.p.*, pancreatic papilla; *sp.p.*, papilla of accessory pancreas.

B: The spleen with accessory spleen (*a*) in the pancreas (*p*).

C & D: The pancreas. *c.b.d.*, common bile-duct; *p.d.*, pancreatic duct; *m.*, mesentery; *py.*, pylorus. Description of other figures in text.

E: Section across the suprarenal capsules. *c.m.*, medulla within cortex. The upper is the left, and the lower is the right capsule.

The stomach is, therefore, very complex and contains divisions corresponding to most of those of the Ruminantia, but the reticulum of these animals is absent.

The Duodenum (text-fig. 11, A).

I have nothing to add to those descriptions of the macroscopic appearances which have already been published. I must, however, record the conditions of the bile and pancreatic ducts which differ from those mentioned by Francaviglia (**4**). The pancreatic duct opens into the duodenum 2·9 cm. distal to the pylorus; it is situated on a papilla. At a point 1·1 cm. posterior to the pancreatic papilla there is a large bile papilla, and 2·7 cm. posterior to the latter there is a small papilla for the duct of an isolated mass of pancreatic tissue. All the papillæ lie on transverse folds of mucosa.

The entire duodenal mucosa is thrown into circular folds which are large at the pyloric end, and small and numerous at the jejunal end.

The Jejunum and Ileum.

Dr. Chalmers Mitchell (**8**) has described the macroscopic appearances in *B. infuscatus*, and mentions the presence of a large cæcal pouch and a small rudimentary cæcum opposite to it. The latter is not present in my specimen, but the remainder of the intestine is the same as that described in Dr. Mitchell's paper. There is no ileo-cæcal valve.

The mucosa exhibits alternating smooth and rugose areas (Plate IV. B, A & B), and there is a strong development of rugæ at the posterior end of the ileum.

The Large Intestine.

In Plate IV. A, C & D, the entire large intestine is exhibited, but the lower end of the ileum is also shown in the former. The canal is, therefore, short, and maintains an almost uniform calibre till the rectum is reached, but the latter gradually expands and its walls become progressively thicker and more muscular. At the anus the walls are exceedingly thick and strong.

The whole of the colon and rectum are bile-stained, especially in the posterior part of the latter, and these parts offer a marked contrast to the pink ileum and anus.

The interior of the large intestine presents several interesting appearances. The colon has many circular folds of varying sizes, but the two most posterior ones form complete diaphragms. In the centre of each of these there is an opening surrounded by a sphincteric valve, the anterior one being the larger. In Plate IV. B, D, a spicule of wood is passed through the two openings. John Hunter (**12**) described three valves in the Two-toed Sloth.

The posterior septum separates colon and rectum, and the appearances of the mucosa differ in these two divisions. In the latter it is excavated into a number of pockets which contain pellets of fæcal matter. These are deepest in the posterior part of

the rectum where the bile-staining is deepest. It also appears as if there had been a strong septum across the rectum, for there is a ridge round the wall.

The anus is surrounded by a tough, strong sphincter, and the mucosa is thrown into many longitudinal folds.

The structure of the whole alimentary tube must be taken into account, in order to understand the physiological significance of the conditions in the rectum. The stomach is complex, as in Ruminants, but the intestinal tube is short, so it is necessary that there be some arrangement to obtain the maximum absorption area in the latter. This is attained by the excavation and folding of the mucous membrane of the latter, and the sphincteric valvular openings in the septa across the colon only allow a small amount of material to pass at a time into the rectum. The powerful anal sphincter muscle is also required to ensure a sufficiently prolonged stay of the intestinal contents, for absorption of water (?) may take place slowly in the rectum.

The reticulum of the Ruminants is absent in the stomach of the Sloth, and the hollows in the rectum resemble the pockets of a reticulum.

The Pancreas (text-fig. 11, c & d).

Rapp (10) and others state that the pancreas extends across the abdomen dorsal to the stomach, but in my specimen it is almost entirely contained within the duodenal loop; none of it lies dorsal to the stomach. It presents features, therefore, which resemble those of the Reptilia.

It is V-shaped and has splenic and duodenal limbs (*sl* and *dl*). The former lies between the right border of the ventral limb of the pylorus on the left and the left border of the spleen on the right. The latter lies along the left border of the duodenum, and the angle of the V runs for a short distance anterior and dorsal to the duodenal loop. A short distance distal to the posterior end of the duodenal limb there is a small isolated piece of pancreas (*sp*).

The entire organ is surrounded by peritoneum, the splenic limb being enveloped by the layers of the dorsal sheet of the great omentum, and the duodenal limb and isolated mass being included between the layers of the common mesentery.

The splenic limb consists of a cylindrical massive part and a lateral lamina, but the latter is wrapped round the former (text-fig. 11, D). Within the massive portion there lies a small spherical accessory spleen. The small isolated piece of pancreas is oval in shape.

The pancreatic duct, contained within the gland, runs along close to the anterior border, receiving tributary ducts as it goes. When it emerges from the end of the duodenal limb it is crossed at right angles by the common bile-duct. It opens into the duodenum at the summit of a prominent papilla. Francaviglia (4), however, saw the duct open along with the common bile-duct.

The small isolated piece of pancreas has its separate duct and papilla.

Histology.

When the pancreas is examined under the low power (×180) it is seen to possess a loose, open texture. The glandular alveoli are either isolated or aggregated loosely into groups, and all are supported by delicate connective tissue. The ducts may be invisible when the cells are loaded with granules, but they appear as clear circular central areas when the cells are not so loaded. Multinucleated areas of different kinds are seen.

Under the high power (×480) the gland-cells are seen to contain granules of different sizes and different degrees of coarseness, and the bases of the cells are the most granular parts. The nuclei are circular, large, and present well-marked granules and networks; in some the granules predominate, but in others the reticulum is the chief feature.

The multinucleated areas differ greatly in appearance, but can be arranged in three groups:—

1. Many nuclei and little surrounding protoplasm.
2. Many nuclei with much protoplasm which stains faintly.
3. Many nuclei with much protoplasm which stains deeply.

In all, the nuclei are of varying shapes and sizes.

The connective tissue may appear as delicate strands round the alveoli, or it may form a strong network within the meshes of which the alveoli are contained. The meshwork is also cellular, and the nuclei are circular or long and narrow.

The Liver.

I have nothing to add to existing accounts of the macroscopic appearances.

Histology (Plate IV. C).

Under the low power it is seen how the cells have the usual arrangement in columns, but each cell has golden-yellow pigment granules in the centre. There appears, therefore, to be a yellow axis running along the centre of the column, for all the cells are filled from end to end with the pigment.

The high power reveals how a few cells are destitute of pigment, so pigmented and non-pigmented cells are to be described. The *unpigmented cells*, which are in the minority, are cubical, hexagonal, or pentagonal in shape. Their protoplasm is faintly granular, and their nuclei are large, round, and granular. The *pigmented cells* cannot have their limits so easily defined, for the pigment granules are tightly packed and obscure their contiguous walls. The granules are coarse or fine and form a central axis, but they never obscure the large, spherical, granular nucleus of the cell. The axis is bordered on either side by the cytoplasm of the cell which is finely granular, but the granules do not consist

of pigment. These granules may, however, have a pathological significance.

The Spleen.

The spleen, as Rapp pointed out (10), lies on the right side of the pylorus. It is, in my specimen, separated from the latter by the splenic limb of the pancreas, with which it is surrounded by the layers of the dorsal sheet of the great omentum (text-fig. 11, B). Its total length is 7·7 cm., width of the oval part 1·3 cm., and thickness ·75 cm.

It consists of an oval posterior part, and a long narrow anterior part which is twice bent on itself, but the latter has a small thick concealed process. On the inner side there is a small circular accessory spleen lying within the splenic limb of the pancreas.

The right-sided position of both pancreas and spleen introduce modifications in the peritoneum. In my specimen the conditions induced by the former make the peritoneum different even to that of forms of *B. tridactylus* in which the spleen and pancreas lie as described by other authors.

The position of the spleen offers a problem for the embryologist.

The Peritoneum.

The Great Omentum (Plate II. A, f).

The great omentum is attached to the right side of the ventral limb of the pylorus, but nowhere is it fixed to the greater curvature of the stomach. It has dorsal and ventral sheets, each composed of two fused layers.

The *ventral sheet* (text-fig. 12, A, *vs*) is attached to the right border of the whole of the ventral limb of the pylorus, and the right border of the first part of the duodenum. It separates into two layers which surround these structures. The ventral layer is continued from the pylorus on to the ventral surface of the cardiac stomach, and the dorsal layer passes from the ventral to the dorsal part of the pylorus, thereby forming the left wall of the lesser sac. On the dorsal limb of the pylorus it meets with the dorsal sheet of the great omentum which has returned from the pancreas and spleen.

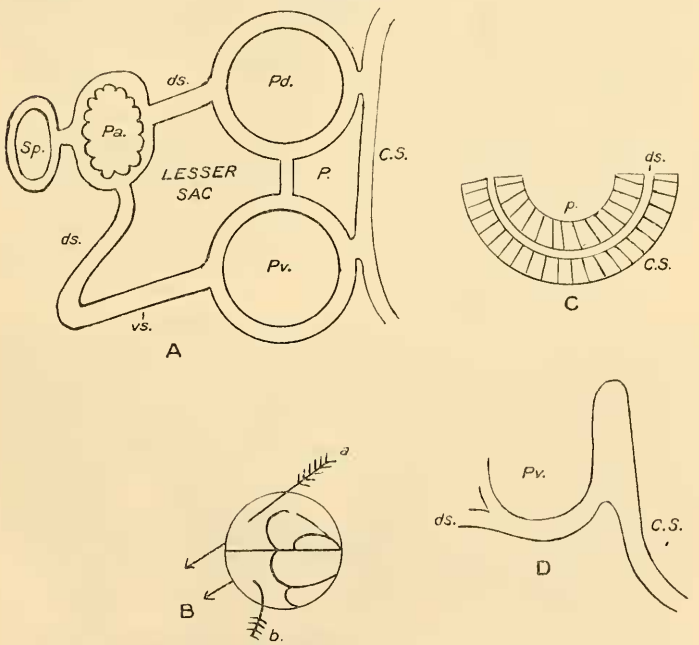
At the convexity of the pylorus the ventral and dorsal sheets meet, thereby closing the lesser sac posteriorly, and the ventral sheet fuses anteriorly with the mesoduodenum (dotted line in text-fig. 14, A).

The *dorsal sheet* (text-fig. 12, A, *ds*) passes dorsally and to the right from the free edge of the omentum and, at the ventral border of the pancreas, it splits into right and left layers. The former passes round on to the right surface of the splenic limb of the pancreas, and is carried off round the spleen which it completely encloses; returning to the pancreas again it covers the right surface. The left layer covers the left surface of the pancreas and, at the dorsal border, the two layers come together

again and run to the dorsal limb of the pylorus. One layer passes thence on to the dorsal surface of the cardiac stomach, and the other unites with the dorsal layer of the ventral sheet. Between the serous covering of the cardiac stomach and the layers passing between the two limbs of the pylorus there is a peritoneal pocket (text-fig. 12, A, p).

When the dorsal sheet is traced to the pyloric curvature it separates into anterior and posterior layers. The former becomes continuous with the part of the ventral sheet running between the two pyloric limbs (text-fig. 12, C, *p*), and the latter passes

Text-figure 12.



A: Section across the great omentum. Dorsal (*ds*) and ventral (*vs*) sheets embracing spleen (*Sp.*), pancreas (*Pa.*), and ventral and dorsal parts of pylorus (*Pv.* & *Pd.*).

B: Section across the cæcal appendage of the stomach.

C & D: The relation of the dorsal sheet of the great omentum (*ds*) to the pyloric curvature. The layers pass to the peritoneal pocket (*p*) and the cardiac stomach (cs).

round the bend and is reflected on to the right surface of the cardiac stomach (text-fig. 12, C, cs).

The posterior pole of the spleen is connected by a fold of peritoneum to the ventral surface of the cardiac stomach, encircling the ventral pyloric limb and curvature. It shuts in a peritoneal pocket containing the ventral limb.

The meso-appendix, which binds the cæcal appendage to the posterior surface of the cardiac stomach, is formed by peritoneum derived from the coverings of both ventral and dorsal surfaces of the stomach. Its attachment to the cardiac stomach is much shorter than to the anterior border of the appendage.

The Gastro-Hepatic Omentum.

The gastro-hepatic omentum runs from the œsophagus, convex lesser curvature of the stomach, and duodenum as far distally as the entrance of the common bile-duct (Plate II. A) to the diaphragm at the left side of the liver, and along the left half of the posterior surface of the liver. It is wide and fan-shaped with the base lying posteriorly and the narrower end fixed to the diaphragm and liver. It fuses with the common mesentery, and the structures forming the ventral boundary of the wide Foramen of Winslow are common to both of them (Plate II. A, L).

When the serous coats of the stomach are traced to the right they are seen to separate and surround the first part of the duodenum and become continuous with the common mesentery (Plate II. A, G). This connection, therefore, forms an additional means whereby the gut is fixed to liver and diaphragm.

The Lesser Sac of the Peritoneum (Plate II. A; text-fig. 12, A).

The long axis of the lesser sac describes an S-shaped course from the Foramen of Winslow to the free edge of the great omentum, and its general direction is posterior and to the right. It is also tapering, for the Foramen of Winslow and part abutting against the liver are much wider than the omental end. It also lies mostly to the right of the stomach, and part of it is anterior. Consequently, the disposition is different from that of most Mammals, where it lies dorsal to the stomach. This curious arrangement is due chiefly to the position of the pancreas, spleen, and great omentum, and the relations of the layers of the omentum to the limbs of the pylorus.

The boundaries of the lesser sac from behind forwards are :—

To the right—pancreas and spleen enveloped by the layers of the dorsal sheet of the great omentum.

To the left—the two limbs of the pylorus and the beginning of the duodenum.

Dorsally—the so-called ligamentum hepato-cavo-duodenale of Klaatsch, which is a continuation of the right half of the suspensory sheet of the liver and covers the vena cava inferior.

Ventrally—the great omentum, pylorus, first part of the duodenum, and the fused sheet produced by the lesser omentum and common mesentery.

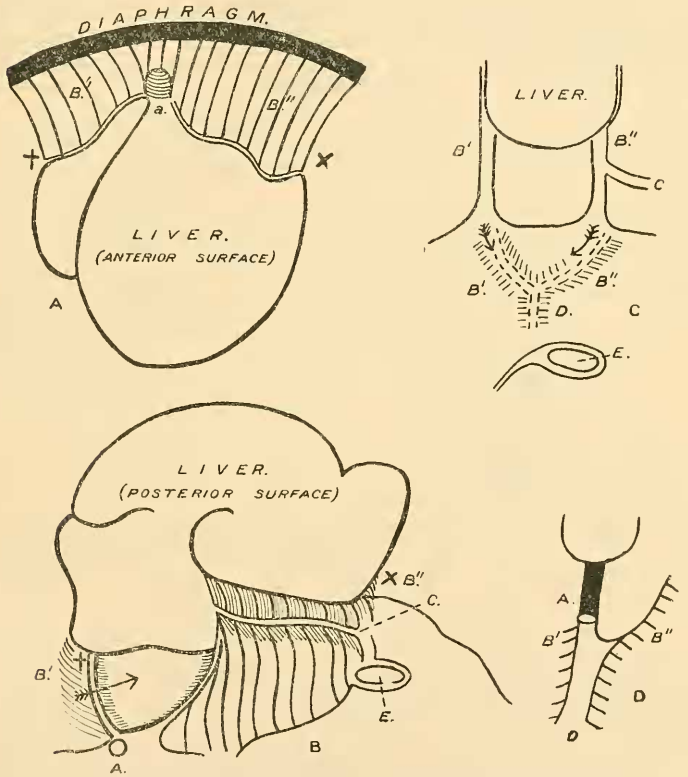
The above conditions resemble in many respects those of some

of the Reptilia, and Klaatsch (5) has described the peritoneum exhaustively in them.

The Foramen of Winslow is also very wide as in the case of Reptiles. It has the usual boundaries.

In Plate II. A the ventral wall of the lesser sac has been removed round the letters MGIJKL and one sees the pancreas (P) in the dorsal wall of the sac.

Text-figure 13.



The suspensory ligaments of the liver and the manner in which their continuations enter into the formation of the anterior part of the common mesentery. Two halves, B′ and B″ of A, pass round the edges of the liver at the points + and ×. They eventually become the mesentery D of figs. C and D. A and *a*, inferior vena cava. *c*: lesser omentum. E: œsophagus.

Ligaments of the Liver.

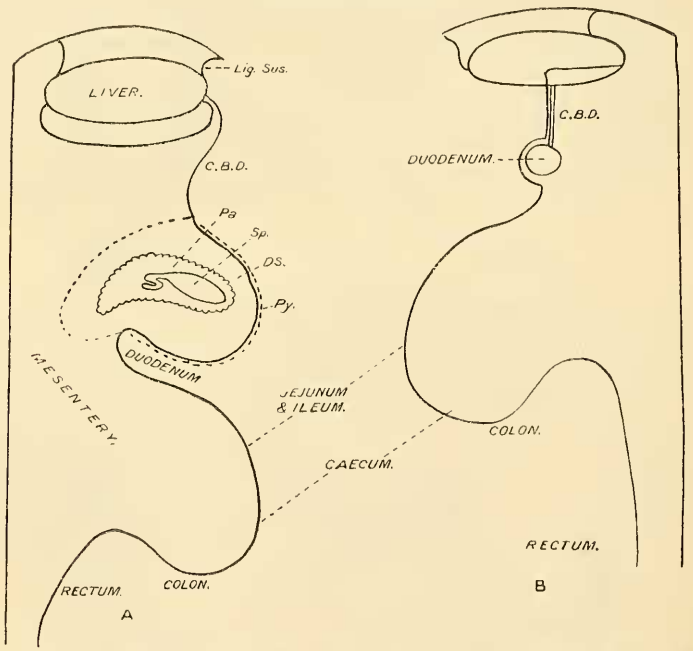
When the liver is depressed so as to show the anterior surface (text-fig. 13, A), one can see how it is connected to the diaphragm by a V-shaped sheet of peritoneum whose apex is dorsal. The

limbs of the sheet play important parts in the formation of the mesentery and the ligamentum hepato-cavo-duodenale of Klaatsch.

The right limb is inserted into the floor of a groove. It passes round the right border of the liver and separates into two layers which pass along the sides of the vena cava inferior. One-half covers the right abdominal wall, and the other covers the dorsal abdominal wall and can be traced into the common mesentery (text-fig. 13, C*d* and D*d*).

In the angle between the two limbs the vena cava inferior, arched over by peritoneum, can be seen (text-fig. 13, A, *a*) running to the diaphragm.

Text-figure 14.



The common mesentery viewed from the right (A) and left (B). *Lig. Sus.*, suspensory ligament; C.B.D., common bile-duct; *Pa.*, pancreas: *Sp.*, spleen; *Py.*, the dorsal and ventral limbs and flexure of the pylorus; the unmarked dotted line is the line of fusion of the great omentum and mesentery.

The left limb of the sheet is the true suspensory ligament. It passes into the fissure between the left and right lobes of the liver. It turns round the left hepatic margin, and is attached to the posterior surface from the left border to the origin of the common bile-duct. The lesser omentum fuses with it. It is continued as the common mesentery, and is combined therein with part of the ligamentum hepato-cavo-duodenale. Between the

two halves is the anterior part of the lesser sac (text-fig. 13, B), which opens into the Spigelian Recess of the liver.

The Mesentery.

The mesentery has an attachment from liver to pelvic floor which begins anteriorly to the right of the mid-line, but passes posteriorly and to the left to reach it. It is composed at first of the suspensory ligament, and its free edge is attached first to the diaphragm, then along the posterior surface of the liver (Plate II. A, N). Its free edge then, containing the common bile-duct, runs from the portal fissure to the duodenum. Finally, it follows the intestine to the pelvic floor. It has attached to it the layers of the great omentum. It sends a tubular sheath round the œsophagus (text-fig. 13, B, E).

The stomach is attached to it anteriorly by the lesser omentum, and to the right by the connection round the duodenum (text-fig. 14, B).

No peritoneal bands connect the duodenum to the colon.

Dr. Chalmers Mitchell (**8**) and others have described the peritoneum from duodenum to anus, and the only fact which I have to add to their accounts is the prominent ridge produced in the mesentery by the posterior mesenteric vessels.

The Suprarenal Capsules.

The left capsule is flat and ovoid and measures :—

Length	1·8 cm.
Width	·75 „
Thickness	·35 „

The right capsule, as is shown by the following figures, is longer, narrower, and thicker :—

Length	2 cm.
Width	·6 „
Thickness	·5 „

Both lie a considerable distance anterior to their corresponding kidneys. On section the right capsule shows a round cortex and medulla, but these are long in the case of the right one (text-fig. 11, E).

The Thoracic Organs.

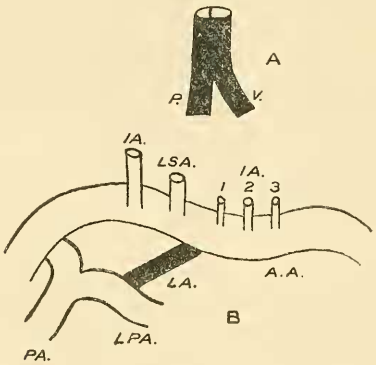
Burne (**1**) and Rapp (**10**) have described the heart and large vessels, but the branches of the aortic arch in my specimen are different to their accounts. It gives off from right to left the innominate, left subclavian, and three intercostal arteries (text-fig. 15, B).

The posterior border of the arch is connected to the left pulmonary artery by a very prominent ligamentum arteriosum ; this measures 1 cm. long and 2 mm. wide, but is quite impervious.

The left vagus and phrenic nerves are fused in the anterior part of the thorax, there being only superficial furrows to mark the distinction between them (text-fig. 15, A).

The lungs have large alveoli, as shewn by John Hunter (12).

Text-figure 15.



A: The adhesion of the left vagus (v) and phrenic (p) nerves.

B: The aortic arch (A.A.) giving off innominate (IA.), left subclavian (L.S.A.) and three intercostal (1 A, 1, 2, 3) arteries; LA., ligamentum arteriosum; PA. and LPA., pulmonary and left pulmonary arteries.

The Generative Organs.

The internal generative organs of the female have been described by John Hunter (12), Klinckowström (6), and Rapp (10). Those of my specimen were not examined, for the gravid uterus was at once removed for embryological research.

The external genitalia and anus are all enclosed in a species of cloaca, and the clitoris is a small semicircular flap. The male organs also exhibit a primitive condition, and John Hunter (12) has described them as follows:—"The penis is a short flat body enclosed in a prepuce which is within the verge of the anus. It is not above two tenths of an inch in length, and terminates in an obtuse point. It has a groove which runs along the under surface, and which makes the point somewhat forked."

No os penis is present.

Ballowitz (15) has described the spermatozoa.

The Pelvic Bones.

The skeleton of the specimen described above was recently obtained by me from Mr. Gerard, and the pelvis was compared with that of a male animal which was preserved in the Society's Prosectorium. There are numerous and striking differences between them; these are seen in the measurements of the different

diameters, the shape of cross-sections of some of the bones, the sizes of openings, and the development of crests and eminences. Speaking generally the female pelvis is rounder and more capacious, for it has to accommodate the large trumpet-shaped rectum, and leave a passage for the fœtus during parturition.

For purposes of measurement I have chosen the following diameters which are made use of in human obstetric anatomy, but have modified them slightly :—

1. *Conjugate*—from the centre of the inner border of the pubis to the front of the centrum of the first sacral vertebra.

2. *Transverse*—between the widest points of the lateral pelvic walls : that is between the inner surfaces of the acetabula.

3. *Oblique*—from the sacro-iliac joint to the mid point of the bone between the mid line in front and the anterior border of the obturater foramen.

4. *Interspinous*—between the iliac spines.

5. The *measurements of the outlet* are taken between the widest points dorso-ventrally and transversely.

The proportions present in male and female pelves are as follows :—

Diameters.	*Male pelvis.*	*Female pelvis.*
Interspinous diameter	9·8 cm.	10·1 cm.
Conjugate of inlet	7·7 ,,	7·5 ,,
Transverse ,, ,,	5·5 ,,	6·8 ,,
Oblique ,, ,,	7 ,,	7·5 ,,
Conjugate of outlet	5·5 ,,	5·7 ,,
Transverse ,, ,,	5 ,,	5·8 ,,
Width of pubis	2 ,,	2·3 ,,
Ischiadic Foramina.		
Antero-posterior diameter	2·3 ,,	1·8 ,,
Transverse ,,	1·6 ,,	1·3 ,,
Obturator Foramina.		
Antero-posterior diameter	1·6 ,,	1·7 ,,
Transverse ,,	2·2 ,,	2·5 ,,

The following differences are also present between a male and female pelvis :—

Male pelvis.	*Female pelvis.*
Ischial tuberosities well marked.	Ischial tuberosities very small.
Pubis circular on section.	Pubis flat on section.
Iliac spines incurved.	Iliac spines not incurved.
Inlet less defined.	Inlet well defined by a sharp crest.
Ischia more sloping from last sacral vertebra.	
Transverse processes of caudal vertebræ sloping.	Transverse process of caudal vertebræ horizontal.

The Sacral and Caudal Vertebræ.

Owen mentions in his 'Comparative Anatomy of the Vertebrata,' that there are six sacral and eleven caudal vertebræ. In both my specimens there are seven sacral and nine caudal vertebræ, but there is a greater degree of fusion, and less distinctness, between the sacral centra in the female pelvis. Flower gives the number of caudal vertebræ as 6–10.

The Blood.

Gulliver (16) has pointed out that the red blood corpuscles are very large, and gives their measurement as 1/2778th inch in diameter in a young *B. didactylus*. He also states that the Elephant is the only mammal with larger corpuscles.

Summary.

The new facts recorded in this communication are :—

a. The full description of the mouth and tongue.

b. The comparison between the palates of *Bradypus* and *Cholœpus*.

c. The external relations of the compartments of the stomach, and the distribution of lymphatic glands in the stomach-wall.

d. Details of the internal structure of the stomach, and a complete account of the interior of the cæcal appendage.

e. The unusual and reptilian-like situation of the pancreas, which results in complications in the peritoneum. The latter is fully described for the first time in *Bradypus tridactylus*.

f. The vessels arising from the aortic arch are different to previous accounts.

g. The ligamentum arteriosum of *Bradypus* is described for the first time.

h. The duct papillæ in the duodenum are different from the form which has already been described.

i. The comparison between the male and female pelves.

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EXPLANATION OF THE PLATES.

Plate I.

A. The anterior end of a section through the head. *l l*, lips.

B. The roof of the mouth: *c*, cheeks; *v*, vestibule; *sp*, soft palate.

C. The bony palate of *Bradypus tridactylus*.

D. The bony palate of *Cholœpus*.

Plate II.

The external (A) and internal (B) structure of the stomach. In B the ventral wall has been thrown upwards and to the right, and the dorsal cardiac compartment and pylorus separated and thrown to the left.

A, C and B, I.II.: paunch.
A, D and B, *d*, *c*, *d*, 2: cardiac stomach.
A, EH and B 3: pylorus.

Description of other letters in text.

Plate III.

The interior of the dorsal compartment of the cardiac stomach (A), dorsal part of pylorus (B), and ventral part of pylorus (C).

A *a*: rod running through the ruminating gutter to the pylorus. *b*, rod communicating with the paunch (*c*). *d*, pleated mucosa.
B *a*: epithelial ridges bounding glandular areas (*b*). *c*, ruminating gutter. *d*, hard pleated mucosa continued from the cardiac stomach.
C *a*: pyloric sphincter with beginning of duodenum (*b*). *c*, cardiac stomach.

Plate IV.

A: The interior of the intestinal tract. A and B, pieces of the small intestines. C and D: the lower end of the ileum, colon, and rectum.

B: Section through the septum between cardiac stomach and paunch.

C: Section of the liver.